Newsletter

Number 11, April 2025

Newsletter Editor
Lianet Mendez-Monsanto, Universidad Carlos III de Madrid, Spain

COST INTERACT Chairman
Laurent Clavier, IMT Nord Europe, France

COST CA20120 ACTION

INTERACT

IN THIS ISSUE:

EDITOR'S ADDRESS

Dear reader,

It is a pleasure to introduce the 11th issue of the INTERACT newsletter. As this is my first time as its editor, I would like to take this opportunity to express my heartfelt gratitude to all of you in this great community. It is an honor to contribute to the action, where I have gained fantastic experiences and grown throughout these years.

In this issue, you will find the highlights from the last meeting in Dublin, Ireland, including updates from all working groups and vertical teams. We also feature inspiring interviews with members of the action: Vasile Bota from the Technical University of Cluj-Napoca (TUCN), Romania, and Sobia Jangsher from last meeting's host institution, Dublin City University (DCU).

Lianet Mendez-Monsanto
Universidad Carlos III de Madrid, Spain

Also, Dheeraj Raja Kumar, from Centre Tecnologic De Telecomunicacions De Catalunya (CTTC), Spain, talks about his very positive experience during his Short-Term Scientific Mission (STSM) at KU Leuven, Belgium.
Very interesting works were presented at the meeting by our partners. As usual, you will find here a summary of the selected scientific topics for this edition.

Enjoy the reading!

ABOUT COST

This COST Action aims at contributing to the societal transformation, by developing the next generation of radio communication networks, 6G.

The Intelligence-Enabling Radio Communications for Seamless Inclusive Interactions (INTERACT) vision is to go beyond the capabilities of the 5G and to make the radio network itself intelligent, meaning aware, adaptive and parsimonious.
Challenges include:

1) Fundamental research in the fields of antennas and propagation, signal processing and localization, network architectures and protocols, to design intelligent-enabling radio communications;
2) Exploitation of Machine Learning tools for the implementation of many aspects of this network intelligence;
3) Collecting real-world data and making them available to the research community by building the INTERACT datasets.

This COST action started in October 2021 and ends in October 2025.

COST EUROPEAN COOPERATION IN SCIENCE & TECHNOLOGY
Funded by the European Union

10th MC & Technical Meeting - Dublin 2025

January 29th, 2025, Dublin (Ireland) - the newcomers' photo.

Announcement on next events

We're excited to share the upcoming INTERACT events with you! Mark your calendars and be sure to join us!

NEXT MEETING: Join us at next INTERACT 11th MC and 11th Technical Meeting at Gothenburg, Sweden.
Venue: Chalmers University of Technology.
Date: 16-19 June 2025.

SEVENTH TRAINING SCHOOL: We are thrilled to announce the next INTERACT Training School:
Short Range Radio Propagation: Theory, Models and Applications
Date: September 15-19, 2025
Location: Dublin City University, Dublin, Ireland
Topics: Channel modelling for medium/short range wireless systems and networks, including millimetre wave and Terahertz, MIMO and UWB technologies for wireless on-body communication, and joint communication and sensing applications. Emerging technologies such Reconfigurable Intelligent Surfaces will also be covered.
Targeted at PhD students, but it is open to industry or academia researchers with an interest in the topics.

Keep checking our Training Schools website for upcoming information about grants and registration!

CHAIRMAN'S ADDRESS

Our meeting in Dublin marked the first meeting of our final year. It was a great pleasure to visit Croke Park and see that there are still amateur sports and teams attracting enthusiastic crowds in a good-natured atmosphere. As we embark on this final leg of our journey, we find ourselves with a tightly packed schedule to write the final report - an important milestone for our work.

I would love, in a few year's time, to look back and feel an ounce of pride in what we have achieved. I would soon realise that this pride was misplaced, that the result was the work of a community, certainly a group of professionals, but whose involvement in the action was almost voluntary.

I doubt we will make it to Croke Park, but let's approach the last few remaining months of INTERACT with enthusiasm. Our collective effort has left a lasting mark on the radio network research community - a community that must be preserved in a world that is so threatening, even for knowledge and research.

INTERVIEW WITH A SENIOR RESEARCHER: VASILE BOTA

PROFESSOR OF DIGITAL TRANSMISSIONS AT TECHNICAL UNIVERSITY OF CLUJ-NAPOCA (TUCN)

Vasile received the Diplomat Engineer Degree at the Polytechnic University Bucharest and the PhD from the TUCN. After several years of designing and manufacturing dial-up modems, he joined the Communications Dept. of TUCN. He has been involved in EC and national-funded projects, and reviewer in the evaluations of projects within the FP7 and H2020 frameworks. Chair of the IEEE ComSoc Romania Chapter for more than 10 years.

What are your favourite areas of interest and research?
Error-correcting codes (ECC), digital modulations and their adaptive employment. Relay-assisted transmissions (RAT) and the distributed use of ECCs in RATs.

What was your motivation to become a researcher?
I was attracted by the challenges of digital transmissions and by their diversity, as well as by the search of the trade-offs required by their implementation.

What is the “next big thing” in the wireless communication area?
The insertion of “controllable” AI that would ensure reliably imposed target KPIs. The quantum communications would be the “second next big thing” in this area.

Considering the innovations in the scientific world in the last 20 years, which was the most remarkable one, which one didn’t get the attention it deserved, and which one finished with a “dead end”?
First, the most remarkable one might be the genetic engineering, with huge implications in therapy and agriculture. Secondly, the CDMA technology should be reconsidered using the new processing capabilities. And, finally, the cognitive radio seemed very promising but ended up in the shared spectrum and dynamic access approach.

How did you become involved in COST INTERACT (or any of the previous Actions)?
I joined COST 289 at the suggestion of prof. H.Rohling, and then I attended COST Actions 2100, 15104, IRACON and INTERACT.

What was your motivation to be part of COST INTERACT?
The possibility to continue seeing the work of excellent researchers and get their comments on my work, and to visit some interesting cities in Europe.

What was your motivation to become a researcher?
I was attracted by the challenges of digital transmissions and by their diversity, as well by the search of the trade-offs required by their implementation.

My favourite holiday is...
Many years ago, wandering in the mountains, with a backpack and a tent was a perfect vacation. Later, visiting interesting cities. Nowadays, as I grew “younger”, a week in a beautiful seaside resort would make a nice holiday.

My favourite book, music, movie are ...
G. Orwell’s “Animal farm” and “1984”; they envisioned the dictatorial system in which I had to live my childhood and youth.
Regarding music, Beethoven’s symphonies and concertos are absolute masterpieces; Jethro Tull, for their elaborated music, lyrics and the synergy between them in their songs.

In few words, I consider myself to be...
Curious, analytical and eager to find out and understand, at least partially, the wonders of nature and the accomplishments of science and art.

What is your country well known for?
Romania is known for hospitality, beautiful landscapes, unaltered villages which preserve old architecture, traditions and tasty cuisine.

My favourite quote is ...
“The devil lies in details”; it is very appropriate for engineers.

INTERVIEW WITH A YOUNG RESEARCHER: SOBIA JANGSHER

ASSISTANT PROFESSOR AT DUBLIN CITY UNIVERSITY

Sobia earned her PhD from The University of Hong Kong, Hong Kong, and her MS and BE from the National University of Science and Technology, Pakistan. She is currently an Assistant Professor at DCU. Previously, she worked at Khalifa University, UAE, and the Institute of Space Technology, Pakistan.

What are your favourite areas of interest and research?
I love working on resource allocation and specifically the formulation part of it.

What was your motivation to become a researcher?
My initial motivation was to go into teaching, as I have always enjoyed explaining concepts and helping students learn. To achieve this, I decided to pursue a higher degree, which led me into research. Along the way, I discovered that I genuinely enjoy the process of research—exploring new ideas and solving challenging problems.

What is the "next big thing" in the wireless communication area?
I feel zero touch telecom network will revolutionize wireless communications.

Considering the innovations in the scientific world in the last 20 years, which one didn't get the attention it deserved, and which one finished with a "dead end"?
Li-Fi (Light Fidelity), a promising wireless communication technology using visible light for ultra-fast data transmission, didn't get the attention it deserved despite its potential for secure, high-speed indoor networking. I am not sure if it is a dead end for it.

What was your motivation to be part of COST INTERACT?
It is the ideal place for networking and collaborations.

How did you became involved in COST INTERACT (or any of the previous Actions)?
Conor Brennan introduced me to it after I joined DCU, and I found it to be a perfect match for my interests, so I became a member.

My favourite book, music, movie are ...
My favourite book is 'Not a penny more, not a penny less' by Jeffery Archer. I love listening to a couple of Pakistani singers Junaid Jamshed and a band Strings. I like watching reality TV.

I'm most passionate about ...
Travelling and food.

My favourite holiday is ...
Where there are beaches with sunsets.

In few words, I consider myself to be...
Resilient.

What is your country well known for?
Food and cricket.

My favourite quote is ...
I had this quote written on my sticky note for years "Some men see things as they are and say 'why?' I dream things that never were and say 'why not?" by George Bernard Shaw

HIGHLIGHTS FROM THE LAST MEETING

WG1 - Radio Channels

Seven WG1-related sessions took place, including three *pure* WG1, SWG 1.1, SWG 1.2, VT4+WG1, and SWG2.1+WG1 sessions. The topics addressed included the analysis of "clusters" and their characteristics, the integration of GSCM models combined with AI/ML, development of standard models for indoors and outdoors, advanced ray models, RT-assisted analysis tools (and with ML), and material characterization. SWG1.1 session featured presentations on double-band THz and sub-THz measurements in street canyon, multi-band material characterization (a collaboration within INTERACT), and a lecture-style presentation on the benefits of time domain models for weakly-dispersive leaky wave antennas. SWG 1.2 session focused on the simulation of RIS-assisted systems, real-life RIS measurements, and a fully ray-based RIS scattering model. Additionally, discussions took place regarding the writing of the final book: editors for Chapter 1 sub-sections have been appointed and a book writing roadmap has been defined.

WG2 - Signal Processing and Localization & SWG2 ISAC

Regarding WG2, there have been nine TDs on localisation, multi-antenna and MIMO technologies, and signal processing. Additionally, six TDs on integrated sensing and communications (ISAC), corresponding to the SWG2.1 have been presented. Topics include localisation algorithms, channel models and performance, wireless power transfer, cell-free massive MIMO, beamforming, modulation and pilot design. These TDs have been organised in five sessions, of which two dealt with ISAC (one with WG1). Additionally, two TDs, one on wireless channel semantic modelling for ISAC and one on synchronisation for ultra-reliable low latency communications (URLLC), have been presented at a plenary session. Discussions about the final book have been initiated. As part of the efforts to train young researchers in the action, one young researcher has volunteered to chair one of the WG2 sessions, very successfully.

WG3 - Network Architectures and Protocols

A single session of WG3 was held, where three TDs were presented and discussed. The first TD conceptualized the benefits of using ground vehicles as moving urban base stations. The second TD provided insights into the potential structure and key performance indicators of digital twins for future wireless networks, while also reviewing ongoing digital twin standardization activities. The final TD examined the performance of the IEEE 802.11ah standard (Wi-Fi HaLow), with a focus on the Enhanced Distributed Channel Access (EDCA) and Restricted Access Window (RAW) mechanisms. Papers led to engaging discussions. The initial book chapter topics were introduced, and editor volunteers were called. It was agreed that details will be shared via the WG3 reflector email.

VT1 - Health and Well-Being

VT1 held one session with three TDs and 19 attendees. The following topics were covered: evaluation of LoRa WAN for remote monitoring of patients in hospitals or homes; a network of passive nano-nodes flowing in the human vascular system and communicating with a nano-router mounted on a vein wall, and the methodology of tailoring synthetic gel phantoms for wideband microwave applications. EMF group had 7 TDs (2 sessions with 30 attendees). The topics covered 6G exposure (compliance of active antennas and RIS; 6G distributed MaMIMO evaluation), 5G exposure measurement methods. The book structure for EMF section was discussed. Workshops, STSM, data sets, and next plans were also mentioned. The EMF INTERACT convened session at EuCAP 2025 with 10 papers was mentioned.

VT2 - Transportation

Two VT2 sessions were held. The presentations provided empirical and theoretical analysis of vehicular communication channels, covering V2V and V2I propagation across sub-6 GHz, cmWave, and mmWave bands. The presentations ranged from real-world measurements to simulations and comparative studies, addressing multiple-antenna characterization, uncorrelated scatter models, and time-varying Rician K-factors, as well as OTFS performance and stochastic geometry-based models for critical vehicular scenarios. We have discussed the progress of the VT2 white paper and finalized the definition of the Table of content and corresponding authors.

VT3 - Industrial Automation

VT3 held a single session with three papers, were different topics were covered, including Doppler measurements inside of machines for ISAC at sub-THz in industrial scenarios, AI-powered smart drying ovens in electrical equipment manufacturing, and line of sight blockage prediction of wireless channels leveraging networked sensing and machine learning on graphs.

VT4 - Smart Building and Cities

Three TDs were presented during this meeting, with some overlap with WG1. The first TD introduces a methodology for Rician K-factor estimation using curve fitting, which performs independently of channel samples, unlike current state-of-the-art approaches. The second TD proposes a machine learning-based approach to generate ray paths in radio propagation modeling, aimed at enhancing computational efficiency while maintaining accuracy. The final TD suggests new power requirement estimations for various technology base stations, addressing the lack of accurate models for recent base stations. Following the TD presentations, we discussed potential editors for the final book chapter and agreed to consolidate its sections.

SELECTED SCIENTIFIC TOPIC:

REFLECTION POINT LOCALIZATION WITHOUT PRIOR ENVIRONMENTAL KNOWLEDGE

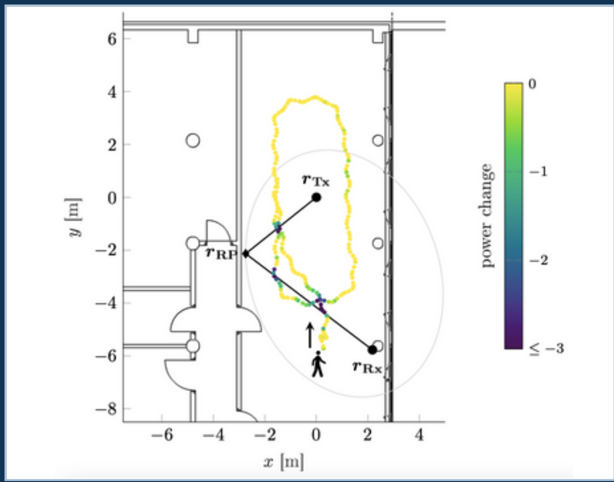
This work proposes a measurement-guided ray tracing approach for the estimation of the reflection point (RP) due to single-bounce reflections (SBRs). The approach does not rely on any prior environmental information, such as floor plans. Instead, it formulates an optimization problem that aligns the parameters of an empirical fading model with time-series data of user-induced power changes. Additionally, the method can simultaneously estimate key parameters of the underlying model.

The authors derive the Cramér-Rao lower bounds to evaluate their proposed approach. Beyond numerical analysis, which highlights the impact of user trajectory on accuracy, the method is tested with ultra-wideband indoor measurements. Results show precise RP localization with minimal deviation from true paths. Additionally, it is demonstrated that the modeled power variations closely match measured time-series data, confirming the method's ability to estimate both RP location and model parameters, even without prior environmental information.

MARTIN SCHMIDHAMMER, BENJAMIN SIEBLER, CHRISTIAN GENTNER, STEPHAN SAND

Contact person
martin.schmidhammer@dlr.de

Given the radio attenuation map in the figure, the method is able to precisely estimate RP location, as well as the maximum modeled power change and decay rate, closely aligning with the measurements.



Floor plan of indoor measurement setup including an initiating and responding node at rTx and rRx, respectively. The radio attenuation map corresponding to a multipath component (MPC), indicated by the location of the reflection point at rRP, illustrates user-induced power changes through a colormap.

SELECTED SCIENTIFIC TOPIC:

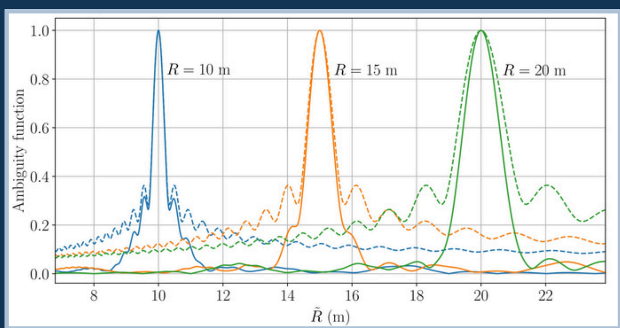
NEAR-FIELD WIDEBAND LOCALIZATION: PERFORMANCE ANALYSIS BASED ON THE AMBIGUITY FUNCTION

Terrestrial mobile networks offer an alternative or complement to GNSS, enabling precise localization even in urban canyons or indoors. The localization technique studied in this work is based on the multiple-input multiple-output (MIMO) technology, where terrestrial access points (APs) are composed of antenna arrays. Next-generation networks are advancing toward extra-large MIMO (XL-MIMO) and exploring THz frequencies. As a result, users will be in the near-field (NF) of APs, where the plane-wave model fails.

NF range estimation has been analyzed only for narrowband signals, while in wideband NF scenarios, performance depends on both NF effects and bandwidth. This work characterizes their combined impact by deriving the ambiguity function and providing a condition to identify the predominant factor.

Therefore, the condition derived by the authors helps in adapting the scenario to meet the desired estimation performance. Bandwidth can be partially saved by increasing the number of antennas, resulting in a larger AP size. Conversely, if the AP size is limited, the required performance can be achieved by increasing the signal bandwidth.

Future work includes extending the study to a cell-free setup with multiple synchronized APs. Additionally, passive sensing will be considered.



Ambiguity functions versus estimated range, for different true range R values. Bandwidth W = 0 MHz (dotted curve) or W = 200 MHz (solid curve). Wavelength λ = 2.14 mm, N = 2048 antennas in AP separated by half a wavelength. In the narrowband case, the ambiguity function is only impacted by the NF effect. Range estimation improves as user gets closer to AP compared to the Fraunhofer distance.

Contact person
laurence.defraigne@uclouvain.be

LAURENCE DEFRAIGNE, LUC VANDENDORPE, JÉRÔME LOUVEAU

SELECTED SCIENTIFIC TOPIC:

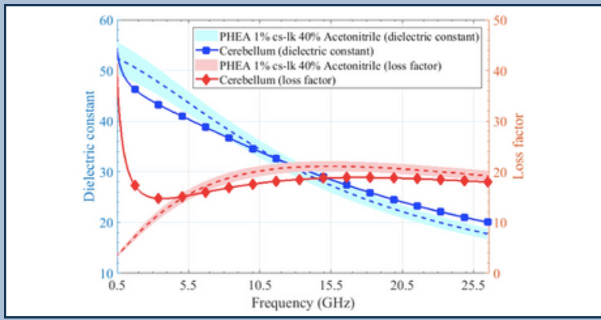
TAILORING SYNTHETIC GEL PHANTOMS FOR WIDEBAND MICROWAVE APPLICATIONS

Developing accurate body phantoms is crucial for testing wearable antennas. While liquid phantoms suit many tissues, solid or gel-based materials offer better shape retention. Traditional gels, made with natural polymers, lack durability and struggle with non-water solvents like acetonitrile. This work proposes as an alternative the poly(2-hydroxyethyl acrylate) (PHEA), a stable synthetic polymer that maintains good mechanical properties and can be reused without significant degradation.

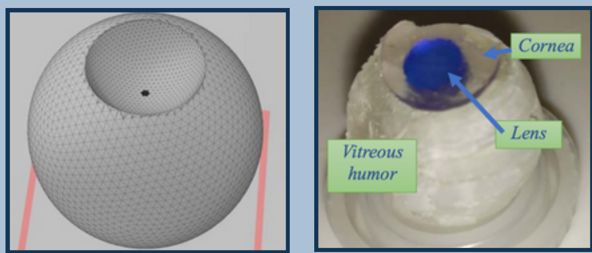
The key novelty of these synthetic gels is their ability to control liquid content and absorb various mixtures, like acetonitrile, making them suitable for wideband phantoms. Measured using the open-ended coaxial method across 2–26.5 GHz, they accurately mimic different tissues. Unlike previous gels, their synthetic nature allows tailoring for both high-water content tissues (e.g., muscle) and low-water content tissues (e.g., bone or fat) through cross-linking. The authors successfully match the dielectric properties of the gels to real tissues across the measured frequency range, as shown in the figure on the right for the cerebellum case.

SERGIO CASTELLÓ-PALACIOS, NARCÍS CARDONA, ANA VALLÉS-LLUCH, AND CONCEPCION GARCIA-PARDO
Contact person
sercaspa@iteam.upv.es

They also assess the radiation performance of on-body mmWave antennas using a three-layer model (muscle, fat, and skin) and a multilayer eye phantom (see figure (below)), both replicating key tissue properties across the studied frequencies.



Relative permittivity of PHEA gels vs. cerebellum values.



Multilayer eye phantom (Cornea, lens, and vitreous humor).

SELECTED SCIENTIFIC TOPIC:

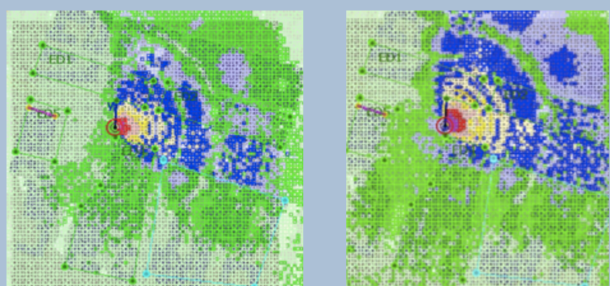
EVALUATION OF EXPOSURE COMPLIANCE AND OF EXCLUSION ZONES FOR ACTIVE ANTENNAS AND RIS IN 5G+

The advancements in 5G and upcoming 6G technologies present challenges in assessing the exposure to electromagnetic field (EMF) and defining exclusion zones around transmitters. Innovations like active antennas, beamforming, massive MIMO, and reconfigurable intelligent surfaces (RISs) introduce highly variable power levels and exposure patterns across space and time. As a result, traditional models assuming constant power and static radiation patterns tend to overestimate exposure. To ensure more accurate evaluations, new methodologies are needed, especially as 5G evolves and future generations are introduced.

This paper presents initial evaluations combining deterministic and statistical methods to assess base station emissions and simplified yet accurate models of RISs. Results indicate that, while exclusion zones are generally small, they must be carefully considered. The study highlights that a purely deterministic approach with simple formulas is insufficient; exclusion zones must be determined case by case using a statistical perspective that accounts for spatial and temporal beam variability.

MARINA BARBIROLI, VITTORIO DEGLI ESPOSTI,
ANDREA GARZIA, SIMONA VALBONESI,
PAOLO GRAZIOSO, BERNARDO GALEGO,
CUSTÓDIO PEIXEIRO AND LUIS M. CORREIA

The paper examines various scenarios, including an urban environment where the figure presents a colour map of the electric field magnitude. Power density calculations are compared with ICNIRP guidelines, showing that when two beams operate at maximum power, exposure can exceed reference levels in some cases. The authors also derive exposure guidelines for RISs, determining the minimum safe distance.



Electric field magnitude with only beam 1 (left) and 8 beams (right) transmitting at full power in urban environment.

Contact person
pgrazioso@fub.it

AVAILABLE GRANTS IN THE INTERACT ACTION

STSM TESTIMONY

Investigating the Application of Graph Neural Network for Hybrid Beamforming in Rate Splitting Multiple Access

Dheeraj RAJA KUMAR (Centre Tecnològic de Telecomunicacions de Catalunya, Spain)

Host institution:
KU Leuven, Ghent, Belgium

I am currently pursuing a doctoral degree in "AI/ML for physical layer designs for 6G and beyond" at CTTC, Barcelona under the supervision of Dr. Carles Antón-Haro and Dr. Xavier Mestre. In the fall of 2024, I had the opportunity to undertake a Short-Term Scientific Mission (STSM) at KU Leuven – Ghent campus, under the guidance of Prof. François Rottenberg. This opportunity emerged from interacting with two of the students who had undertaken STSM at CTTC in previous years. There was a synergy with respect to the use of graph neural networks in both research groups which paved way for undertaking this short research stay.

The main topic investigated was related to the design of graph neural network (GNN) architecture for optimizing the digital precoders of hybrid beamforming in rate splitting multiple access. The research involved evaluating different GNN architecture designs, associated computational complexity in training and prediction phase, and performance comparison with conventional benchmarks. The weekly meetings with the host research group were very supportive and engaging throughout the STSM. The outcomes of this collaboration included a Temporary Document which was presented at the COST meeting in Dublin, and an accepted conference paper at ICMLCN 2025 in Barcelona.

I am very grateful to have been awarded this STSM which definitely strengthened the research collaboration between the two institutions. This valuable experience during my PhD studies opens multiple research avenues for the near future. I definitely recommend and encourage young researchers to take up any opportunity to conduct short-term research stays. There will always be something new to learn and live.

WOMEN IN INTERACT

As shown in the figures below, bridging the gender gap remains a key priority for INTERACT. We are committed to increasing the visibility and impact of women, driving meaningful change for a more diverse future. To support this, we keep exploring platforms like podcasts to showcase female researchers' achievements and insights. Our **Mentorship Program** remains open to all young researchers, and we continue prioritizing opportunities for young researchers, regardless of gender, to co-chair sessions at our meetings.

This time, at the Dublin meeting, we had a slightly different event: *Drink for YR and Women in INTERACT*. The relaxed atmosphere allowed for closer conversations between young researchers and senior colleagues, with a focus on women in INTERACT. Several interesting discussions arose, and plans to potentially develop some of them throughout the year were considered.

We invite you to share your ideas on how we can further improve gender equality within our community.

FACTS & FIGURES

Signatory Countries:	**46**
COST Cooperating Members:	**1**
COST Partner Members:	**1**
International Partners:	**5**
Institutions (University/ Industry/ Research Infrastructures/Enterprises) currently participating:	**228**

INTERACT Action's Members

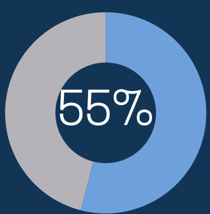
667

Participating last meeting

88 on site

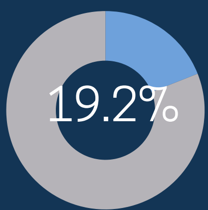
25 online

Young Researchers



55%

Women



19.2%

Presented TDs in Dublin

59

Meetings per year

3

Training School/Day completed

1/3